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Leather testing methods

The official methods of the International Leather Chemists' Societies for chemical leather analysis are denoted by the letters **IUC** and that for the physical testing of leather by the letters **IUP**. Most of them have been adopted as official methods.

The official leather test methods of the German Standard Committee are denoted by the letters DIN. Most of them have been drawn up in conformance with the IUC and IUP methods.

Methods of chemical leather analysis

IUC/1 General remarks and presentation of analytical results
= factually corresponding with DIN 53300/Blatt 2 (10.68)
(Das Leder 14, 95–96, 1963)
(JSLTC 49, 6, 1965)

IUC/2 Sampling (as in IUP/2)
= factually corresponding with DIN 53302/Blatt 2 (5.68)
(Das Leder 14, 96–97, 1963)
(JSLTC 49, 8, 1965)

IUC/3 Preparing the test material by disintegration
= factually corresponding with DIN EN ISO 4044

IUC/4 Determination of substances extractable with dichloromethane
= factually corresponding with DIN EN ISO 4048

IUC/5 Determination of the water content of leather
= factually corresponding with DIN 53304 (12.77)
(Das Leder 14, 167–168, 1963)
(JSLTC 49, 11, 1965)

IUC/6 Determination of organic and inorganic substances in leather removable by washing (loss by washing)
= factually corresponding with DIN 53307 (1.78)
(Das Leder 14, 168–169, 1963)
(JSLTC 49, 13, 1965)

IUC/7 Determination of ash and water-insoluble mineral substances
= factually corresponding with DIN EN ISO 4047

IUC/8 Determination of chromium content
= factually corresponding with DIN 53309 (10.68)
(Das Leder 14, 170, 1963)
(JSLTC 49, 17, 1965)

IUC/9 Determination of water soluble magnesium salts in leather (epsom salt)
= factually corresponding with DIN EN ISO 5399

(IUF methods see chapter "Testing of leather dyes and leather dyeings")

IUC/10 Determination of nitrogen, ammonium and skin substance
= factually corresponding with DIN 53308 (10.68)
(Das Leder 14, 201, 1963)
(JSLTC 49, 23, 1965)

IUC/11 Determination of pH and difference value of aqueous leather extract
= factually corresponding with DIN EN ISO 4045

IUC/13 Determination of zirconium
= no corresponding DIN test method available
(ISLTC 59, 1, 1975)

IUC/15 Determination of phosphorus
= no corresponding DIN test method available
(JSLTC 57, 46, 1973)

IUC/16 Determination of aluminium
= no corresponding DIN test method available
(JSLTC 53, 388, 1969)

IUC/17 Determination of hydroxyproline
= no corresponding DIN test method available
(JSLTC 64, 57, 1980)

DIN standards not within the IUP range:

DIN 53314 Determination of chromium (VI) compounds in leather

DIN 53315 Determination of formaldehyde in leather

The following methods are in the course of preparation and have not yet been adopted as official methods:

a. Determination of iron in leather

b. Determination of free fatty acids in leather

d. Determination of extractable fat (chamois leather)

e. Determination of sulphur in leather

f. Determination of glutaraldehyde in leather

g. Determination of pentachlorophenol (PCP) in leather

(IUF methods see chapter "Testing of leather dyes and leather dyeings")

Methods of physical leather testing

IUP /1 General remarks
(Das Leder 10, 14, 1959)
(JSLTC 42, 382, 1958)

IUP/2 Sampling
= factually corresponding with DIN 53302, Blatt 1 (5.68)
(Das Leder 10, 14–15, 1959)
(JSLTC 42, 382–386, 1958; 48, 377, 1964; 51, 283, 1967; 52, 420, 1968)

IUP/3 Conditioning in standard atmosphere
(65 ± 2% RH and 20 ± 2 °C; DIN 50% RH, 23 °C)
= factually corresponding with DIN 53303/Blatt 1 (2.79)
(Das Leder 10, 15–16, 1959)
(JSLTC 42, 386–387, 1958; 48, 377, 1964)

IUP/4 Measurement of thickness
= factually corresponding with DIN 53326 (5.78)
(Das Leder 10, 16, 1959)
(JSLT 42, 387–388, 1958)

IUP/5 Measurement of density
= factually corresponding with DIN 53327 (12.70)
(Das Leder 10, 16, 1959)
(JSLTC 42, 388–389, 1958; 48, 377, 1964)

IUP/6 Measurement of tensile strength, elongation at break and maximum force
= factually corresponding with DIN 53328 (2.79)
(Das Leder 10, 16–18, 1959)
(JSLTC 42, 389–392, 1958; 48, 377, 1964; 60, 125, 1976)

IUP/7 Measurement of absorption of water (Kubelka)
= factually corresponding with DIN 53330 (5.78)
(Das Leder 12, 36–37, 1961)
(JSLTC 44, 367–368, 1960)

IUP/8 Measurement of tearing load
= factually corresponding with DIN 53329 (2.82)
(Das Leder 12, 37, 1961)
(JSLTC 44, 368–370, 1960; 48, 377, 1964; 71, 125, 1987)

IUP/ 9 Measurement of distension and strength of grain by the ball burst test (Lastometer)
= factually corresponding with DIN 53325 (1.74)
(Das Leder 12, 38–40, 1961)
(JSLTC 44, 374–379, 1960)

IUP/10 Dynamic waterproofness test (Penetrometer)
= factually corresponding with DIN 53338/Blatt 1 (4.76)
(Das Leder 12, 38–40, 1961)
(JSLTC 44, 374-379, 1960)

(IUF methods see chapter "Testing of leather dyes and leather dyeings")

IUP/11 Dynamic waterproofness test for boot and shoe sole leather
= factually corresponding with DIN 53338/Blatt 2 (5.78)
(Das Leder 12, 64–65, 1961)
(JSLTC 44, 495–497, 1960; 47, 381, 1963; 48, 377, 1964)

IUP/12 Measurement of resistance to grain cracking
= factually corresponding with DIN 53324 (5.73)
(Das Leder 12, 65–67, 1961)
JSLTC 44, 380–383, 1960; 48,377, 1964)

IUP/13 Measurement of two-dimensional extension (Tensometer)
= factually corresponding with DIN 53323 (1.74)
(Das Leder 12, 304–306, 1961)
(JSLTC 45, 311–313, 1961)

IUP/14 Measurement of the waterproofness of gloving leathers
= no corresponding DIN test method available
(Das Leder 12, 85–86, 1961)
(JSLTC 44, 498–502, 1960)

IUP/15 Measurement of water vapour permeability
= factually corresponding with DIN 53333 (4.78)
(Das Leder 12, 86–88, 1961)
(JSLTC 44, 502, 1960; 48, 377, 1964; 69, 85, 1985; 72, 1988)

IUP/16 Measurement of shrinkage temperature
= factually corresponding with DIN 53336 (1.77)
(Das Leder 15, 85–87, 1964)
(JSLTC 47, 122, 1963)

IUP/17 Measurement of resistance of air-dried insole leather to heat, particularly during direct vulcanization
= no corresponding DIN test method available
(Das Leder 19, 130–131, 1968)
(JSLTC 50, 379, 1966; 51, 117, 1967; 51, 279, 1967)

IUP/18 Determination of the resistance of air-dried lining leather to heat, particularly during direct vulcanization
= no corresponding DIN test method available
(Das Leder 20, 161–163, 1969)
(JSLTC 53, 151, 1969)

IUP/19 Determination of the resistance of dry upper leather to heat, particularly in direct vulcanization and in moulding on soles during shoe production
= no corresponding DIN test method available
(Das Leder 20, 39–41, 1969)
(JSLTC 52, 378, 1968; 52, 419, 1968)

IUP/20 Determination of the flexing endurance of light leathers and their surface finishes (dry and wet) in flexometer
= factually corresponding with DIN 53351 (1.83)
(Das Leder 15 + 20, 87 + 163, 1964 + 1969)
(JSLTC 47, 126, 1963; 48, 377, 1964; 67, 94, 1982)

(IUF methods see chapter "Testing of leather dyes and leather dyeings")

IUP/21 Measurement of set in lasting with the dome plasticity apparatus (Plastometer)
= no corresponding DIN test method available
(Das Leder 15, 294–259, 1964)
(JSLTC 47, 96, 1963; 47, 379, 1963; 48, 377, 1964)

IUP/22 The assessment of surface damage by use of the viewing box
= no corresponding DIN test method available
(Das Leder 15, 295–298, 1964)
(JSLTC 47, 101, 1963; 47, 380, 1963)

IUP/23 Measurement of damage caused by scuff
= no corresponding DIN test method available
(Das Leder 15, 298–299, 1964)
(JSLTC 47, 107, 1963; 47, 380, 1963; 48, 377, 1964)

IUP/24 Measurement of surface shrinkage by immersion in hot water
(JSLTC 48, 369, 1964)

IUP/26 Measurement of abrasion resistance of sole leather
(JSLTC 53, 470, 1969)

IUP/28 Measurement of resistance to bending of heavy leather
(JSLTC 53, 155, 1969)

IUP/29 Determination of cold crack resistance of finishes
(JSLTC 69, 85, 1985)

IUP/30 Determination of water vapour absorption and desorption in relation to dimensional changes in the leather
(JSLTC 67, 92, 1983)

IUP/32 Measurement of surface area (provisional draft) (ISO 11646)

(IUF methods see chapter "Testing of leather dyes and leather dyeings")

DIN standards not within the IUP range:

DIN 53331	Determination of stitch tear strength.
DIN 53332	Determination of water vapour absorption.
DIN 53334	Air permeability test.
DIN 53340	Determination of flexing endurance of low flexibility leathers.
DIN 53344	Determination of resistance for hydrolysis of finished and unfinished leathers.
DIN 75201	Determination of fogging characteristics of trim materials in motor vehicles.
	Method A: determination with 60° reflectometer.
	Method B: gravimetric determination.
DIN 75202	Determination of light fastness of trim materials in motor vehicles using the Xenon arc light.

DIN 4841/Part 1 and DIN 4841/E = Protective gloves.

DIN 4843 Protective shoes.

(IUF methods see chapter "Testing of leather dyes and leather dyeings")

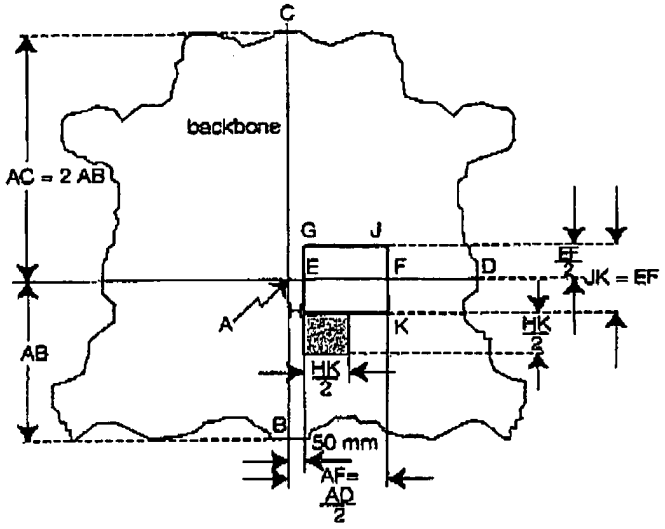
Preparation of sample for analysis

The leather specimen for the chemical analysis is passed through a cutter mill, and the pulverized leather is called "leather powder" or ground leather.

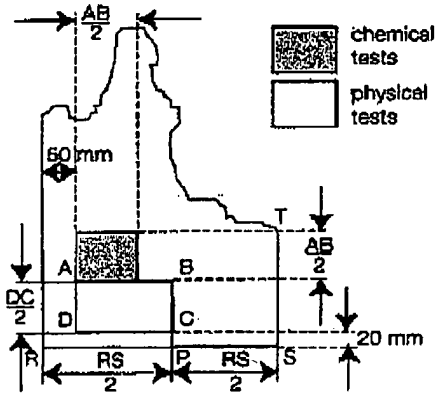
Suitable for this purpose are all types of mills fitted with a 4 mm screen and driven at a speed of 700–1000 r.p.m.

Sampling according to IUC/2 and IUP/2

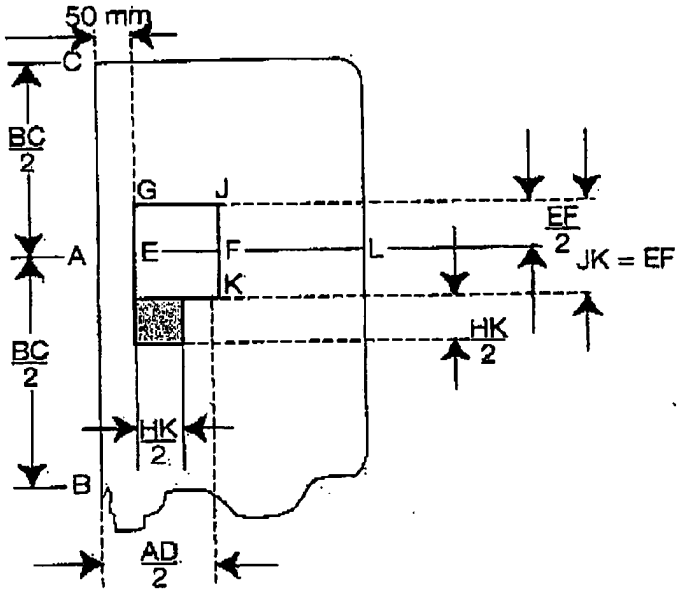
1. Sampling location for skins, whole hides and sides



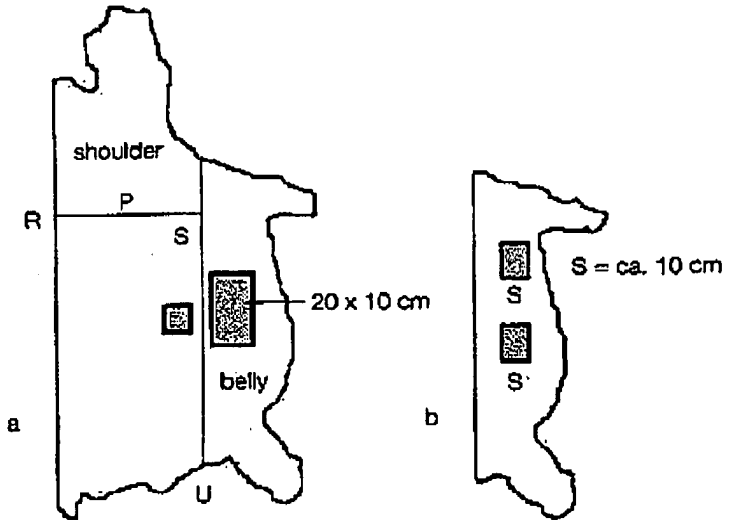
2. Sampling location for shoulders



Sampling location for bends



3. Sampling location for bellies (flanks)



a. sampling location, if no physical tests are required
b. sampling location, if physical tests are required

Calculation and evaluation of test results

Determination of water content

$$\text{Water content in \%} = \frac{G_1 - G_2}{G_1} \cdot 100$$

G_1 = weight of sample before drying
G_2 = weight of sample after drying

Determination of substances extractable with dichloromethane
(fats and other soluble substances)

$$\text{Extractable substances in \%} = \frac{\text{g extract} \cdot 100}{\text{g weight of sample}}$$

Determination of substances removable by washing

a. $$\text{Total loss washing in \%} = \frac{\text{g solids}}{\text{g weight of sample}} \cdot 100$$

b. $$\text{Sulphate ash removable by washing in \%} = \frac{\text{g sulphated residue on ignition}}{\text{g weight of sample}} \cdot 100$$

c. Organic substances removable by washing in % = difference between total loss by washing and sulphated ash removable by washing.

Determination of ash

a. $$\text{Total ash in \%} = \frac{\text{g total sulphated ash}}{\text{g weight of sample}} \cdot 100$$

b. Water-insoluble ash in % (determined by calculation) = % total sulphated ash minus % sulphated ash removable by washing.

Determination of chrome

a. Iodometric determination of chrome

$$\% Cr_2O_3 = \frac{\text{ml/0.1 N Na-thiosulphate solution} \cdot 0.002534}{\text{g weight of sample}} \cdot 100$$

b. Titration with iron (II) sulphate solution

$$\% Cr_2O_3 = \frac{\text{ml/0.1 N Iron (II) sulphate solution} \cdot 0.002534}{\text{g weight of sample}} \cdot 100$$

c. Photometric determination of chrome

$$\% Cr_2O_3 = \frac{\text{mg } Cr_2O_3 \text{ test soln.} \cdot \text{ml sample stock soln}}{1000 \text{ g} \cdot \text{g weight of sample} \cdot \text{ml part stock soln.}} \cdot 100$$

Determination of water-soluble magnesium salts

$$\% MgSO_4 \cdot 7H_2O \text{ (Epsom salt)} = \frac{\text{ml 0.01 m komplexon (III) solution}}{\text{g weight of sample}} \cdot 0.2465$$

Determination of total nitrogen content, content of ammonium salts, calculation of skin substance

a. $$\% \text{ total nitrogen} = \frac{\text{ml 0.5 N acid} \cdot 0.007}{\text{g weight of sample}}$$

b. Ammonium nitrogen content in % N $$= \frac{\text{ml aqueous extract} \cdot \text{ml 0.1 acid} \cdot 0.0014}{\text{ml aqueous part extract} \cdot \text{g weight of sample}}$$

Ammonium sulphate content in $\% (NH_4)_2 SO_4 = \%$ N · 4.71

c. Skin substance in % = % total nitrogen minus ammonium nitrogen content in % · 5.62

Difference value

The difference value is the difference between the pH of a solution and hat of its 1:10 dilution.

Fixed tannin (vegetable)

% fixed tannin = 100 minus the sum of moisture, ash, fat, organic loss by washing and skin substance.

Degree of tannage (vegetable)

The degree of tannage indicates the number of parts of tannin fixed by 100 parts of skin substance.

$$\text{Degree of tannage} = \frac{\text{\% fixed tannin}}{\text{\% skin substance}} \cdot 100$$

Yield value (analytical)

The yield value indicates the amount of vegetable tanned leather containing 14% of water obtained from 100 g skin substance.

$$\text{Yield value} = \frac{10000}{\text{\% skin substance}}$$

Apparent density

$$\text{Apparent density in g/cm}^3 = \frac{\text{mass (weight) of leather in g}}{\text{volume of leather in cm}^3}$$

$$\text{Volume of leather} = \frac{d^2 \text{ (in cm)} \cdot 3.14 \cdot \text{average thickness (in cm)}}{4}$$

Measurement of tensile strength, elongation at break, breaking load

$$\text{Tensile strength in daN/cm}^2 = \frac{\text{daN breaking load}}{\text{thickness in cm} \cdot \text{width in cm}}$$

Breaking load daN = highest load reached at break

$$\text{Elongation at break in \%} = \frac{\text{mm length at break} - \text{mm initial length}}{\text{mm initial length}} \cdot 100$$

Measurement of tearing load (split tear strength)

Split tear force in daN = mean value of tearing load

Tearing load in daN = force applied to tear specimen

Stitch tear strength (according to old DIN 53329)

$$\text{In daN/cm} = \frac{\text{daN load} \cdot 10}{\text{mm leather thickness}}$$

Water absorption after Kubelka (static)

$$\text{Water absorption in \% by vol.} = \frac{\text{volume of water absorbed in ml}}{\text{volume of sample in cm}^3}$$

$$\text{Water absorption in \% by wt.} = \frac{\text{weight of water absorbed in g}}{\text{mass weight of sample in g}}$$

Static waterabsorption (simple test)

A piece of leather (ca. 10x10 cm) is completely immersed in water for a defined period (1 or 2 hours).

$$\text{Static waterabsorption in \% by wt.} = \frac{\text{weight before storage}}{\text{weight after storage}}$$

Stripe test

A stripe of leather (ca. 10x1 cm) is hung into water for 2 hours up to a defined mark. The distance the water has risen at the surface and at the edge is determined in mm.

Water absorption, water penetration in penetrometer (dynamic)

(Bally penetrometer test)

The most suitable flexing amplitude depends on the thickness of the leather, viz. 5%, 7.5%, 10% or 15%.

Penetration time is recorded in minutes.

$$\text{Water absorption in \%} = \frac{\text{weight sample after flexing - weight before flexing}}{\text{weight of sample before flexing}}$$

Water transmitted in g = gain in weight of absorbent cloth

Maeser test (ASTM D 2099)

Test specimens are flexed in a dilute solution of common salt . The number of flexes endured by the leather at the point at which the water penetrates are counted. The dynamic water absorption is often tested after 15000 to 20000 flexes or at the point of penetration.

Dynamic waterproofness test for sole leather (penetrometer) (dynamic)

Evaluation of the penetration time and the water absorption in the same way as in the penetrometer test. The amount of water transmitted is determined by the weight increase of the absorbent cellulosic board and is indicated

$$\text{in g/dm}^3 \cdot \text{h}.$$

Water vapour permeability (IUP 15)

$$\text{Water vapour permeability in mg/cm}^3\text{/h} = \frac{7640 \cdot m}{d^2 \cdot t}$$

m = gain in weight in mg between two weightings
d = inner diameter in mm in bottle neck
t = time in minutes between two weighings

Air permeability (DIN 53334)

$$\text{Air permeability coefficient } K = \frac{V \cdot 100}{p \cdot T \cdot F}$$

V = volume of air in cm^3
p = excess of diminished pressure in cm mercury column
T = rate of transmission in minutes
F = free area tested in cm

Abrasion resistance of sole leather

a. Stather/Herfeld method
Abrasion coefficient K = percentage of loss in weight of leather after 100 revolutions, calculated on 5 mm thick leather sample.

$$K = \frac{G_1 - G_2}{G_1} \cdot \frac{D}{U} \cdot 2000$$

G_1 = initial weight of leather sample
G_2 = end weight of leather sample
D = thickness of sample in mm
U = revolutions of emery disc

b. Method according to DIN 53863 (for textiles)
Loss by abrasion (loss by abrasion in weight/area) tested in Schopper apparatus; the results are reported in g/m^2 or mg/mm^2.

Quality requirements for the main types of leather
(General data)

	Shoe upper leather							
	Box calf	Box side	Corrected grain side	Glazed kid	Waterproof (comb. tanned)	Water proof (chrome tanned)	Vegetable tanned leather	Suede (cattle, calf, goat, sheep)
Sulphate ash %	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 1.5	< 2.0
Chromium oxide content %	> 2.5	> 2.5	> 2.5	> 2.5	> 1.2	> 2.5	–	> 2.5
Fatty substances %	3–8	5–16	5–16	4–8	<16	8–15	18–26	2–6
Loss by washing %	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 6.0	–
Degree of tannage	–	–	–	–	> 30	–	> 50	–
pH (1:20)	aqueous extract not below pH 3.5;							
Tensile strength daN/cm²	>200	>200	>200	>200	>250	>250	>250	>200
Elongation at break %	< 80	< 80	< 80	< 80	< 80	< 80	< 70	< 75
Elongation in % at 20 daN/cm²	< 14	< 14	< 14	< 14	< 16	< 14	–	–
Split tear force daN/cm	> 40	> 40	> 25	> 25	> 50	> 50	> 40	–
Stitch tear strength daN/cm	> 80	>100	> 80	> 80	>100	>120	>100	> 80
Water penetration in min (penetrometer)	> 20	> 20	> 20	> 20	>180	>120	> 20	–
Water absorption after 30 min	< 30	< 30	< 30	< 30	< 20	< 25	< 30	–
Water absorption – Kubelka after 2 h	< 60	< 60	< 60	< 60	< 30	< 30	< 35	<100
after 24 h	< 85	< 85	< 85	< 85	< 40	< 40	< 45	<125
Water vapour permeability (Herfeld)	>300	>300	>250	>250	>200	>200	>180	>250
Air permeability value	> 80	> 80	> 80	> 80	> 80	> 80	> 80	> 80
Apparent density g/cm³	–	–	–	–	–	–	–	–
Abrasion (Schopper)	–	–	–	–	–	–	–	–
Grain distension (Lastometer), mm	> 7,0	> 7,0	> 7,0	> 7,0	> 7,0	> 7,0	> 7,0	–

Test methods, leather testing

	Sole leather			Lining leather			
	Sole leather modern tannage	Sole leather old pit tannage	Insole leather	Insole, sock lining (sheep), Combination tanned	Vegetable tanned	Combination tanned	Chrome tanned
Sulphate ash %	< 2.5	< 0.7	< 2.0	< 2.0	< 3.0	< 2.0	< 2.0
Chromium oxide content %	–	–	–	< 0.8	–	< 0.5	< 2.5
Fatty substances %	< 3.5	< 2.0	< 4.0	< 4.0	4–8	5–11	5–11
Loss by washing %	<14.0	< 6.0	<10.0	<10.0	< 6.0	< 3.0	< 3.0
Degree of tannage	60–95	60–95	60–95	> 50	>50	>40	–
pH (1:20)	at pH values below 4.0 difference value not above 0.7						
Tensile strength daN/cm²	>250	<250	>200	>100	>150	>150	>200
Elongation at break %	< 30	< 35	< 35	< 40	< 70	<100	<100
Elongation in % at 20 daN/cm²	–	–	–	–	–	–	–
Split tear force daN/cm	–	–	–	–	> 15	> 15	> 40
Stitch tear strength daN/cm	>130	>130	>125	–	> 40	> 40	> 40
Water penetration in min (penetrometer)	–	–	–	–	–	–	–
Water absorption after 30 min	–	–	–	–	–	–	–
Water absorption – Kubelka after 2 h	< 40	< 40	> 50	> 50	> 75	> 75	> 75
after 24 h	< 50	< 50	–	–	>100	>100	>100
Water vapour permeability (Herfeld)	–	–	>200	>250	>350	>359	>300
Air permeability value	> 20	> 20	> 20	>200	>200	>200	>200
Apparent density g/cm³	<1.15	<1.15	<1.15	–	–	–	–
Abrasion (Schopper)	<400	<300	–	–	–	–	–
Grain distension (Lastometer), mm	–	–	–	–	–	–	–

Quality requirements for the main types of leather
(General data)

	Upholstery and light leather				Clothing leather			
	Upholst. leather, veget. tanned	Upholst leather,. comb. tanned	Upholst. leather, chrome tanned	Light leather. veget. tanned	Clothing leather, chrome tanned	Glove leather, chrome tanned	Glove leather water repellent	Hat sweat band leather veg. tanned
Sulphate ash %	< 2.5	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 5.0
Chrome oxide cont. %	–	> 0.8	> 2.5	–	> 2.5	> 2.5	> 2.5	–
Fatty substances %	5–11	5–11	5–11	3–8	<16–18	10–18	<23	4–12
Loss by washing %	< 7.0	< 7.0	–	< 6.0	< 2–3	< 2.0	< 2.0	< 6.0
Degree of tannage	>50	>30	–	>50	–	–	–	>50
pH-value (1:20)	aqueous extract not below pH 3.5;							
Tensile strength daN/cm²	>200	>250	>275	>100	>250	>250	>200	>120
Elongation at break %	< 50	< 50	< 75	< 50	< 60	< 50	> 50	–
Elongation in % at 20 daN/cm²	–	–	–	–	< 20	< 20	> 20	–
Split tear force daN/cm	> 40	> 40	> 50	> 10	> 35	> 35	> 35	> 15
Stitch tear strength daN/cm	>100	>100	>110	–	>100	>100	>100	> 30
Water penetration in min. (penetrometer)	–	–	–	–	> 40	–	>180	–
Water absorption after 30 min.	–	–	–	–	< 25	–	< 25[1]	–
Water absorption – Kubelka after 2 h	–	–	–	–	–	–	–	>130
after 24 h							–	>150
Water vapour permeability (Hertald)	–	–	–	–	>350	–	–	–
Air permeability value	–	–	–	–	–	–	–	–
Apparent density g/cm³	–	–	–	–	–	–	–	–
Abrasion (Schopper)	–	–	–	–	–	–	–	–
Grain distension (Lastometer), mm	–	–	–	–	–	–	–	–

1) after 180 minutes

Test methods, leather testing

	Technical leather						
	Oil tanned leather	Harness leather veget. tanned	Harness leather, chrome tanned	Football leather, chrome tanned	ASA leather, chrome tanned	Raw hide a. transparent leather.	Chamois leather
Sulphate ash %	< 6.0	< 2.5	< 2.0	< 2.0	< 2.0	< 1.5	< 6.0
Chrome oxide cont. %	–	–	> 2.5	> 2.5	> 4.0	–	–
Fatty substances %	<35	<25	<25	4–10	5–13	–	<10
Loss by washing %	–	< 7.0	–	–	–	–	–
Degree of tannage	–	>30	–	–	–	–	–
pH-value (1:20)	at pH values below 4.0, difference value not above 0.7[1]						
Tensile strength daN/cm²	>350	>200	>275	>300	>150	>600	>100
Elongation at break %	< 90	< 50	< 75	< 70	< 70	< 35	< 50
Elongation in % at 20 daN/cm²	–	–	–	–	> 8	–	–
Split tear force daN/cm	–	> 40	> 50	> 40	> 30	–	> 15
Stitch tear strength daN/cm	–	>100	>110	>120	> 75	–	> 35
Water penetration in min. (penetrometer)	–	–	–	–	–	–	–
Water absorption after 30 min.	–	–	–	–	–	–	–
Water absorption – Kubelka after 2 h	–	–	–	< 35	–	–	>300[2]
after 24 h				< 70			>400[3]
Water vapour permeability (Herfeld)	–	–	–	–	–	–	–
Air permeability value	–	–	–	–	–	–	–
Apparent density g/cm³	–	–	–	–	–	–	–
Abrasion (Schopper)	–	–	–	–	–	–	–
Grain distension (Lastometer), mm	–	–	–	–	–	–	–

1) for chamois leather pH 4.0–10.0; for raw skin and transparent leather pH 4.0–8.0
2) after 2 minutes;
3) after 60 minutes

Provisional quality requirements for shoe upper leather
(laid down by the German leather industry and the General Association of the German Shoe Industry)

Test/type of leather	Quality requirements dry	wet
1. Flexing endurance (flexometer) (DIN 53351/IUP 20 Use DIN 53340 for testing low flexibility leather		According to DIN 53351 leather is moistened
Patent leather	20000	10000
Other types of leather	50000	20000
Laminated splits (over 0.15 mm)	150000	30000
2. Adhesion of finish (IUF 470; N/10 mm width)		
Cattle hide leather, full grain and slightly corrected	3.0	2.0
Cattle hide leather, deeply buffed	5.0	3.0
Fashionable leather (with thin finish coats, e.g. box calf, glazed kid, lamb skin leather)	2.0	
3. Rub fastness (VESLIC rub tester) (DIN 53339)	Rub cycles	Grey Scale
Leather for street shoes		
Test fabric dry, leather dry	50	minimum rating 3
Test fabric wet, leather dry	50	
Leather for shoes without lining		
Inside; test fabric dry	50	minimum rating 4
Inside; test fabric wet	50	
Inside; test fabric wetted with alkaline perspiration solution	20	
Fashionable leather		
Test fabric dry, leather dry	50	minimum rating 3
Test fabric wet, leather dry	20	
Test fabric wetted with aqueous solvent-free polish, leather dry	20	
4. Fastness to hot plating (DIN 53342/IUF 458)	minimum 80 °C	
Patent leather (hot air test with leather extended and lacquer coat perforated)	no cracks	

Test/type of leather	Quality requirements	
5. Distention of grain (DIN 53325/IUP 9)	Dome height minimum 7.0	
6. Split tear force (DIN 53329, method B)		
Leather for lined shoes	minimum 18 N	
Leather for unlined shoes	minimum 25 N	
7. Substances extractable with dichloromethane (DIN 53306/IUC 4)		
for one-component adhesive	up to 9%	
for two-component adhesive	up to 14%	
for special polyurethane adhesive	above 14%	
for vulcanizing	up to 8%	
for PVC mould-on	up to 15%	
8. Water vapour permeability (DIN 53333)		
After 20000 flexes in flexometer (DIN 53351) with finished leathers		
Full grain leather	1.0 mg/(cm² x h)	
Slightly corrected grain leather not for patent leather)	0.8 mg/(cm² x h)	
9. Wettability test		
10. Water spotting test (IUF 420)		
Tests as required		
Tensile strength (DIN 53328/IUP 6)	minimum 150 N	
Grain distention and elongation test for special leathers, e.g. clogs		
Lastometer test (DIN 53325)	dome height minimum 9.0 mm	
Elongation test (DIN 53328)	without grain cracking min. 35%	
Waterproofness test (DIN 53338/IUP 10)	Water penetr.	Water absorpt.
Upper leather for winter boots	min. 60 min	max. 35%
Other shoe upper leathers	min. 30 min	max. 35%
Waterproof leather	min. 120 min	max. 25%
Water vapour absorption (DIN 4843)	min. 10 min	max. 25%
Cold flexing endurance (DIN 53351)		
at –10 °C	min 30000 flexes	
Lightfastness (IUF 401 – daylight)	min. rating 3	
(IUF 402 – xenotest)	min. rating 3	
Migration fastness (DIN 53343)	max. rating 3	
pH value of aqueous extract	not below 3.5	
Mineral substances removable by washing	not above 1.5	

Provisional quality requirements for shoe lining leather
(laid down by the German Leather Associations)

Test/type of leather		Quality requirements aniline leather	finished leather
1. Rub fastness test (DIN 53339 cotton test fabric)	Rub cycles	Staining of test fabric (DIN 54002)	
Leather dry/test fabric dry	100	> rating 4	> rating 4
Leather dry/test fabric wet	50	> rating 3	> rating 4
Leather wet/test fabric dry	20	> rating 3	> rating 4
Leather dry/test fabric wetted with perspiration solution (pH 9)	20	> rating 3	> rating 4
Leather dry/test fabric wetted with gasoline(boiling point 80–110 °C)	20	no staining	
2. Stripe test for water fastness Testing after 2 h and 8 h (Das Leder, 1976, 113–116)		no staining of diffusion zone = rating above 3	
3. Water vapour permeability minimum 1.0 mg/cm² h			
4. Elongation at break (DIN 53328) (minimum leather thickness > 0.4 mm)			
Skivers, unlaminated		minimum	25%
Skivers, laminated		minimum	30%
Other leathers		minimum	30%
5. Mineral substances removable by washing (DIN 53307)		not over	1,5%
6. Substances extractable with dichloromethane (DIN 53306)			
Lining leather		maximum	10%
Lamb woolskin lining		maximum	8%
7. pH value (DIN 53312)		not below	3.5
8. Split tear strength(as required) (DIN 53329)		only lining leather for reinforcement minimum 15 N	

Provisional quality requirements for furniture leather
(laid down by German Leather Associations)

Test/type of leather	Quality requirements dry	wet	perspiration solution
1. Rub fastness test			
(DIN 53339 = rub cycles)			
Rough leather	50	20	20
Grey Scale contrast	maximum rating 3		
Smooth leather	500	80	50
Grey Scale contrast	maximum rating 4		
2. Light fastness (DIN 54004)	minimum rating 3		
3. Flexing endurance (DIN 53351)	20000		
4. Adhesion of finish coat (IUF 470)	2,0 N/cm		
5. Split tear force (DIN 53329)	20 N/mm thickness		
6. pH value, aqueous extract (DIN 53312)	minimum 3.8		

Tests not required but to be carried out if necessary:

migration fastness,
scratch resistance,
stability to UV light,
stability to amines.

For **car upholstery** leather, the individual companies of the automobile industry have different quality standards of their own.

Provisional quality requirements for clothing leather
(laid down by the EC Leather Institutes, Specification Commission)

Test/type of leather	Quality requirements	
	suede leather, nubuck, aniline nappa	nappa leather, finished
1. Light fastness		
IUF 401 – daylight or	rating 4	rating 4
IUF 402 – xenotest	rating 3 (WGR*)	
2. Rub fastness (IUF 450)	Rub cycles	
Felt dry	20	50
Felt wet	10	20
Felt wetted with perspiration solution (pH 9)	10	20
3. Flexing endurance (IUP 20) (IUF 470)	–	>50000 (>100000 **)
4. Adhesion of finish (IUF 470)	–	>2,5 N/10 mm (= 250 p/cm) (WGR=200 p/cm)
5. Split tear strength (IUP 8)	20 N/mm	30 N/mm (= 30 kp/cm) (WGR 25 N/mm)
Tests as required		
Tensile strength (IUP 6)	–	12 N/mm^2 (= 120 kp/cm^2)
Washability (based on IUF 423)	After washing, drying and light staking: no change in leather handle; change in leather shade > rating 3 on Grey Scale (4 is recommended). Change in area < ±3% (BLMRA** < ±5%).	
Resistance to dry cleaning	After dry cleaning/ refatliquoring: no change in handle, shade >rating 3–4, change in area< ±3% (BLMRA ±5%).	After dry cleaning/ refatliquoring: no peeling of finish; changes as specified for suede and nubuck.
Wettability (based on IUF 420)	10 minutes	15 minutes
pH value (IUC 11)	minimum 3.5 EMPA >3.3; diff. value <0.70)	minimum 3.5

* *WGR = Westdeutsche Gerberschule Reutlingen*
** *Eidgenössische Materialprüfungsanstalt/Schweiz*
***BLMRA =* *British Leather Manufacturers Research Association*

ALCA analytical methods compared to ASTM methods (1991)

ALCA No.	Methods	ASTM No.
A 1	Analysis of Vegetable Tanning Materials – General	D 4899
A 10	Preparations of Solution of Liquid Extracts	D 4901
A 11	Prep. of Solution of Solid, Pasty and Powdered Extracts	D 4905
A 12	Cooling of Analytical Solutions	D 4905
A 13	Evaporation and Drying of Analytical Solutions	D 4902
A 20	Total Solids and Water	D 4903
A 50	Lignosulphonates (Sulphite Cellulose)	D 4900
B 2	Preparation of Sample for Analysis	D 2813
B 3	Moisture	D 3790
B 4	Solvent Extract	D 3495
B 5	Nitrogen Content and Hide Substance (Kjeldahl)	D 2868
B 8	Water Soluble Material	D 2876
B 11	Insoluble Ash	D 2875
B 15	Total Ash	D 2617
B 20	pH of Leather	D 2810
C 1	Chromium in Chrome Tanning Liquors	D 3898
C 5	Acidity of Chrome Tanning Liquors	D 3813
C 10	Basicity of Chrome Liquors	D 3897
D 1	Preparations of Samples for Chemical Tests	D 2813
D 10	Chromic Oxide in Leather (Perchloric Acid Oxidation)	D 2807
D 20	Sulphates (Total, Neutral and Combined Acid)	D 4655
D 21	Chlorides	D 4653
D 30	Sulphate Basicity	D 4654
D 35	Acidity (pH value)	D 2810
E 1	Conditioning Leather for Physical Testing	D 1610
E 2	Area	D 2346
E 3	Thickness of Units	D 1814
E 4	Thickness of Specimens	D 1813
E 5	Width	D 1516
E 10	Tongue Tear Strength	D 4704
E 11	Buckle Tear Strength	D 4831
E 12	Stitch Tear Strength, Single Hole	D 4786
E 13	Stitch Tear Strength, Double Hole	D 4705
E 14	Bursting Strength, BAN	D 2207
E 15	Tensile Strength	D 2209
E 16	Breaking Strength	D 2208
E 17	Elongation	D 2211
E 30	Water Absorption (Static)	D 1815
E 32	Permeability to Water Vapour	D 5052
E 42	Resistance to Cracking at Low Temperature	D 1912
E 45	Compressibility of Leather	D 2213

ALCA No.	Methods	ASTM No.
E 46	Crocking	D 5053

Test methods, leather testing

E 52	Corrosion Produced by Leather in Contact with Metal	D 1611
E 53	Colourfastness/Transfer of Color in the Washing of Leather	D 2096
E 54	Flex Testing of Finish on Upholstery Leather	D 2097
E 55	Dynamic Water Resistance of Shoe Upper Leather by Dow Corning Leather Tester	D 2098
E 56	Dynamic Water Resistance of Shoe Upper Leather by the Maeser Water Penetration Tester	D 2099
E 57	Resistance to Wetting of Garment Type Leather (Spray Test)	D 1913
E 58	Grain Crack and Extension of Leather by the Mullen Test	D 2210
E 59	Slit Tear Resistance of Leather	D 2212
E 60	Thermal Conductivity of Leather with the Cenco-Fitch-App.	D 2214
E 61	Chrome-Tanned White Shoe Upper Leather to Artificial Resistance of Perspiration	D 2322
E 62	Apparent Density of Leather	D 2346
E 63	Relative Stiffness of Leather by Means of Torsional Wire Apparatus	D 2214
E 64	Break Pattern of Leather (Break Scale) Oils, Greases and their Products	D 2941
H 5	Sulphonated and Sulphated Oils – General	D 500
H 40	Moisture	D 500
H 41	Moisture & Volatile Matter	D 500
H 42	Organically Comb. Sulphuric Anhydride Titration Test (sulphat.)	D 500
H 43	Comb. Sulphuric Anhydride Extraction Test (for sulphated Oils)	D 500
H 44	Sulphuric Anhydride Ash-Gravimetric Test (true sulphonated)	D 500
H 46	Total Active Ingredients	D 500
H 47	Unsaponifiable Non-Volatile Matter	D 500
H 48	Inorganic Salts	D 500
H 49	Total Alkalinity and Total Ammonia	D 500
H 50	Acidity as Free Fatty Acids or Acid Number In Absence of Ammonia or Triethanolamine Soaps	D 500
H 51	Acidity as Free Fatty Acids or Acid Number In Presence of Dark Coloured Oils but in Absence of Ammonia or Triethanolamine Soaps	D 500
H 52	Acidity as Free Fatty Acids or Acid Number In Presence of Ammonia or Triethanolamine Soaps	D 500
	Sampling	
J 1	Sampling Light Leather for Physical Tests	D 2813
J 2	Sampling Heavy Leather for Physical Tests	D 2813
J 15	Sampling of Vegetable Tanned Leather	D 2813
J 25	Sampling of Mineral Tanned Leather	D 2813
	Leather Finishes	
K 1	Total Solids and Ash in Leather Finish	D 4906
K 5	Nitrocellulose in Finish on Leather	D 4906
K 11	Tackiness of Finish on Leather	D 4908

Testing of leather dyes and leather dyeings

IUF methods

The methods of the International Fastness Union for Leather Dyes and Dyed Leather are denoted by the letters **I.U.F.** = International Union Fastness.

The following countries are at present members of the International Fastness Union: Belgium, Czech Republic, Denmark, France, Germany, Great Britain, Greece, India, Israel, Italy, Japan, Netherlands, Spain and Switzerland.

Numbering system of guidelines and test methods (IUF 105)

Group 1 = includes Nos. 100–199
Scope, principle, assessment; preparation of substrates for producing dyeings.

Group 2 = includes Nos. 200–299
Testing the properties of dyes and finishing agents without the aid of leather.

Group 3 = includes Nos. 300–399
Testing the properties of dyes and finishing agents by application on leather.

Group 4 = includes Nos. 400–499
Testing the colour fastness of leather.

IUF test methods

IUF 105 = Numbering system of guidelines and test methods
IUF 120 = Principles of test procedures
IUF 131 = Grey Scale for assessing the change in colour
IUF 132 = Grey Scale for the determination of the colouring of the accompanying material
IUF 151 = Production of standard chrome calf leather preserved for storage
IUF 201 = Solubility of leather dyes
IUF 202 = Colour fastness of dye solutions to acids
IUF 203 = Stability of dye solutions to acids
IUF 205 = Stability of dye solutions to hard water
IUF 401 = Colour fastness of leather to daylight
IUF 402 = Colour fastness of leather to artificial light (xenon lamp)
IUF 420 = Colour fastness of leather to water spotting
IUF 421 = Colour fastness of leather to water
IUF 423 = Colour fastness of leather to washing
IUF 424 = Colour fastness of leather to formaldehyde
IUF 426 = Colour fastness of leather to perspiration
IUF 434 = Colour fastness of leather to dry cleaning (D) (ISO 11643)
IUF 435 = Colour fastness of leather to washing in the washing machine (D)
IUF 441 = Colour fastness of leather in respect of staining crude crepe rubber
IUF 442 = Colour fastness of leather in respect of staining plasticized polyvinyl chloride
IUF 450 = Colour fastness of leather to rubbing (D)
IUF 454 = Colour fastness of leather to buffing (D)
IUF 455 = Colour fastness to rubbing of leather wetted from the back
  a. with organic solvents (D)
  b. with water (D)
IUF 456 = Colour fastness of leather to rubbing with pad wetted with cleaning agents (D)
IUF 458 = Colour fastness of leather to hot ironing (D)
IUF 470 = Determination of adhesion of finish to leather (ISO 11644)

(D) = draft or VESLIC methods

Testing of leather dyes

Determination of dye class

a. precipitation reaction
b. behaviour in dissolving

Determination of pure dye content

a. determination of ash
b. spectrophotometer

Testing of homogeneity

a. blowing test
b. capillary method

Determination of solubility (IUF 201)

The solubility is tested in distilled water at 20 °C and 60 °C. The amount of dye is determined that stays dissolved after dissolving by boiling and cooling down to the temperatures specified above. The results are recorded in g/l.

Solubility ratings:

5 =	more than	40 g/l
4 =	up to and including	40 g/l
3 =	up to and including	30 g/l
2 =	up to and including	20 g/l
1 =	up to and including	10 g/l

Intermediate ratings, e.g., 3–4, may be given.
(For the technique of low temperature dyeing (below 40 °C), the dyes to be used should be tested especially for this purpose.)

Testing of dye solutions

Strength of dye solution

Assessment without dyeing test on leather. This can be carried out with the aid of:
a. colorimeter
b. filter paper.

Stability to acids (IUF 203)

The resistance of a dye solution to flocculation under the action of formic acid and sulphuric acid.

Ratings:

5 = no flocculation with either one of the two acids
4 = no flocculation with formic acid; beginning flocculation with sulphuric acid
3 = no flocculation with formic acid; flocculation with sulphuric acid
2 = beginning flocculation with formic acid
1 = distinct flocculation with both acids

Fastness to acids (IUF 202)

The resistance of the shade of dye solutions to dilute acids. For testing, the dye solutions are poured on filter paper.

The assessment is made with the aid of the Grey Scale.

Ratings: from 5 = no change in shade
to 1 = strong change in shade

Fastness to alkali

The resistance of the colour of dye solutions to dilute alkalis. For testing, the dye solutions are poured on filter paper.

The assessment is made with the aid of the Grey Scale.

Ratings: from 5 = no change in colour
to 1 = strong change in colour

Stability to hard water (IUF 205)

The behaviour of dyes in water of 20 and 40 German degrees of hardness.

Water of the degree of hardness specified above is prepared by dissolving the required amount of calcium chloride and magnesium sulphate in distilled water.

The purpose of this test is mainly to find out whether a dye for brush or spray staining has to be dissolved in condensation water.

Ratings:

5 = no flocculation with hard water
4 = no flocculation with water containing 200 mg CaO per litre, beginning flocculation with water containing 400 mg CaO per litre
3 = no flocculation with water containing 200 mg CaO per litre, distinct flocculation with water containing 400 mg CaO per litre
2 = beginning flocculation with water containing 200 mg CaO per litre
1 = distinct flocculation with water containing 200 mg CaO per litre

Testing of leather dyeings

Fastness to formaldehyde (IUF 424)

Determination of the change in shade of dyed leather under the action of formaldehyde fumes.

The assessment is made with the aid of the Grey Scale.

Ratings:	from 5	= no change
	to 1	= strong change in shade.

Fastness to fatliquor

The bleeding in anionic fatliquor is assessed according to the behaviour of chrome calf leather dyed with 1% of dye and subsequently fatliquored with 2% of Lipoderm Liquor PN and left in the wet state for two hours under a load between two sheets of filter paper.

The staining of the filter paper is assessed with the aid of the Grey Scale.

Ratings:	from 5	= no change
	to 1	= strong staining.

Penetration

The dye penetration is tested on freshly tanned chrome calf leather (neutralized and subsequently dyed) and on crusted chrome suede leather.

Assessment (leather cross-section)

5 = complete penetration
4 = 75% penetration
3 = 40% penetration
2 = 25% penetration
1 = superficial colouring

Levelling power

Can be assessed only on several leathers or batches of leather. The levelness of the dyeing over the entire leather surface and the colouring or covering up of leather faults are assessed.

Fastness to water spotting (IUF 420)

Two drops of distilled water are dropped on the surface of the leather to be tested. After one drop of water has evaporated at 20 °C, the change in shade of the leather is determined with the aid of the Grey Scale. The remainder of the water of the other drop of water is removed with filter paper after 30 minutes, and any physical change is recorded.

Fastness to water (IUF 421)

Like the test for fastness to perspiration, but demineralized water is used instead of the perspiration solution.

Fastness to washing (IUF 423)

This property is tested by washing leather with a solution of 5 g/l lauryl sulphate in a neutral (alkali-free) bath and assessing the change in shade and staining of accompanying textile fabric.

The leather specimens are attached to equal sized cuttings of accompanying fabric and washed in 50 times their weight of 0.5% lauryl sulphate solution for 30 minutes at 40 °C in a "Wacker" drum.

The change in shade is assessed with the aid of the Grey Scale for change in shade and the staining of the accompanying fabric is determined with the aid of the Grey Scale for bleeding.

Ratings: from 5 = no change in shade or staining
to 1 = strong change in shade or staining.

Fastness to perspiration (IUF 426)

Specified, undyed multifibre fabric (ISO 105-F 10 = cellulose acetate, cotton, polyamide, polyester, acrylic and wool) or homogeneous fibre material soaked in artificial perspiration solution and laid on the side of the leather cutting to be tested. The composite test specimen is placed under a load of 4.5 kg (123 N/cm = 125 p/cm) at 37 ± 2 °C for one hour in a suitable apparatus (hydrotester or perspirometer) and is then dried freely suspended under standard climatic conditions (20 °C and 65% R.H.).

On finished leathers, the film is removed with abrasive paper (grit size 180) without damaging the grain surface to any extent.

Perspiration solution per litre: 5.0 g sodium chloride, NaCl;
5.0 g tris-(hydroxymethyl)-aminomethane, $NH_2C(CH_2OH)_3$;
0.5 g urea, NH_2CONH_2;
0.5 g nitrilotriacetic acid, $N(CH_2COOH)$; adjusted to pH 8.0 ± 0.1 with hydrochloric acid.

Report the numerical ratings for the colour change of each side of the specimen and the numerical rating for the staining of each piece of the specified accompanying fabric with the aid of the Grey Scale.

Ratings from 5 = no staining or no colour change
to 1 = strong staining or strong colour change.

Fastness to solvents

Specimens of 1% dyeings (0.5 g) are placed for 24 hours in 20 ml of the appropriate solvent and bleeding of the dye in the solvent is then assessed.

Any solvent desired can be used.

Ratings:

5 = no bleeding in the solvent
4 = slight bleeding in the solvent
3 = appreciable bleeding in the solvent
2 = strong bleeding in the solvent
1 = very strong bleeding in the solvent

Fastness to dry cleaning (IUF 434 E)

Accurately measured leather specimens are drummed in a "Wacker" drum for 30 minutes with a solvent, e.g. perchloroethylene or R 113 (trifluorotrichloroethane), together with a specified accompanying multifibre fabric (e.g., ISO 105-F 10) and TEFLON balls (specified size), with or without addition of triolein and solvent soaps. The treated leather specimens are placed between blotting paper under a load of 4.5 kg for 1 minute and aired off. They are then examined for change in shade, handle, colour, staining of the accompanying fabric and, if necessary, for changes in wettability, light fastness and rub fastness (dry and wet).

Dry and wet rub fastness

Testing by hand
a. Dry: Rubbing with an untreated white cotton cloth tightly stretched over a cork stopper. Rub ten times back and forth with constant pressure.
b. Wet: Same procedure as in the dry test, except that the cotton cloth is moistened with distilled water and squeezed off to about 100% water uptake.

Test with VESLIC rub fastness tester (IUF 450)
A dry felt pad or a felt pad moistened with water in the prescribed way is rubbed back and forth under a load of 1 kg on the leather that has been stretched by 0% or 10%.

Dry: 20, 50 and 150 rub strokes (if necessary up to 300 and 500 rub strokes)
Wet: 10 and 50 rub strokes

Report the numerical ratings with the aid of the Grey Scale for the staining of the wool felt and for the change in colour of the leather.

Fastness to diffusion into crude rubber crepe (IUF 441)

The behaviour of the dyeing with regard to migration of dye from the leather into crude rubber crepe is tested. The test specimen is bonded on the side to be tested to crude rubber crepe using white pigmented crude rubber solution and is exposed under a load of 4.5 kg at 50 °C for 15 hours.

The assessment is made with the aid of the Grey Scale.

Fastness to diffusion into PVC (IUF 442)

The behaviour of the dyeing with regard to migration of dye from the leather into plasticized polyvinyl chloride is tested.

The assessment is made with the aid of the Grey Scale.

Fastness to buffing of dyed leather (IUF 454)

The behaviour of the dyed leather is tested by buffing. The leather side to be tested is rubbed back and forth 10 to 110 times on the VESLIC rub fastness tester with a carborundum emery paper (grit size 320) under a load of 500 g.

The assessment of change in colour between the lanes after 10 to 110 rub strokes is made with the aid of the Grey Scale. Before the assessment of the change in colour, the buffed area is brushed in the direction of the nap.

Light fastness

a. Fastness to daylight (IUF 401)
b. Fastness to artificial light (Xenon lamp IUF 402)

Leather specimens of not less than 1 cm x 6 cm are exposed to daylight or artificial light under prescribed conditions together with eight light fastness standards which consist of pieces of wool cloth dyed with standard blue dyes of different degrees of fastness.

Standard	Colour Index designation
1	= C.I. Acid Blue 104
2	= C.I. Acid Blue 109
3	= C.I. Acid Blue 83
4	= C.I. Acid Blue 121
5	= C.I. Acid Blue 47
6	= C.I. Acid Blue 23
7	= C.I. Solubilized Vat Blue 5
8	= C.I. Solubilized Vat Blue 8

The fastness is assessed by comparing the fading of the leather specimen with that of the standards. The result is expressed in a numerical fastness rating.

1 = very low
2 = low
3 = moderate
4 = fairly good
5 = good
6 = very good
7 = excellent
8 = outstanding

Intermediate ratings can be given.

For leather testing, the ratings from 1 to 6 will suffice, because the test results are influenced by the amounts and types of tanning agents, fatliquors and auxiliaries used and by the strength of the dyeing and the dyeing method.

Testing of leather finishes

Dry and wet adhesion (IUF 470)

Measurement of the adhesion (anchorage) of a finish coat to the leather surface.

a. Quick reference test method with adhesive tape.

b. Quantitative measurement in the tensile strength testing apparatus. Leather strips of specified length and width are bonded with a specified adhesive to a firm supporting surface which has been cleaned with hexane or a mixture of alkane at a boiling range of 40–60 °C. The bonded specimens are then stripped off in the tensile strength tester at an angle of 90 degrees. At least 4 specimens are tested, two of each in the cross and longitudinal directions to the backbone line.

For the wet adhesion test, the bonded specimens are placed in a glass filled with water. The glass with the specimens is evacuated three times in a vacuum dissicator at 5 kPa maintaining the vacuum each time for 2 minutes. The time between the placing of the specimens into the water and the measuring should be from 60 to 120 minutes.

Composition of adhesive:
A two-component polymer adhesive is used.
20 g Solids Desmocoll 400 dissolved in 800–1000 g ethyl acetate
+ 5 g Hardener Desmodur L 75

The prepared adhesive mixture should be used up within 8 hours after addition of the hardener.

Dry and wet rub fastness

Assessment of the resistance of the finished leather surface to abrasion, scuffing and staining.

a. Quick reference test by rubbing with a white cloth under the pressure of a finger.

b. Test with SATRA rub fastness tester
Rubbing a rotating felt pad under a given load for a specified number of revolutions against the finished leather surface. The dry rub fastness is tested with a dry felt pad under 2.5 kg load, and the wet rub fastness test with a wet felt pad under 0.75 kg load.

c. Test with VESLIC rub fastness tester (IUF 450)
Rubbing a dry felt pad or a felt pad moistened in a prescribed way under a pressure of 1 kg back and forth against the leather that has been stretched by 10%.
Dry rub fastness: leather dry, felt dry, 50–1000 rubbing strokes.
Wet rub fastness: leather dry, felt wetted, 20, 50, 150, 300 rubbing strokes.

Assess the degree of damage or change in the finish coat, staining of the felt pad and change in colour of the test specimen.

Resistance to swelling

Assessment of the behaviour of a finish coat when the whole leather is submitted to the action of water.

a. Quick reference test by immersing the leather specimen in water and rubbing subsequently with a dry cloth.

b. Test with VESLIC rub fastness tester

The leather specimen is immersed in water for 1 hour, and a dry felt is then rubbed back and forth 20–2000 times under a load of 1 kg on the leather.

Rating as in the dry and wet rub fastness tests.

Flexing endurance (IUP 20)

Measurement of the flexing endurance of leathers and their surface finishes through an angle of 22.5 degrees over a prolonged period. The test is carried out with the Bally flexometer, and the leather specimen is examined after 1000, 5000, 10000 and every additional 10000 flexings up to 50000 flexings.

Assessment of damage:

a. Damage to the finish may be of the following kinds: greying, minor and major surface cracks or complete breakthrough, peeling or powdering, loss of adhesion of the finish to the leather or loss of adhesion of one finish layer to another.

b. Damage to the leather may be of the following kinds: cracking of grain layer, development of coarse grain folds (pipey grain), loss of an embossed grain pattern, breakdown of fibres to such an extent that a hole develops through the entire thickness of the leather.

This test can be carried out with both dry and wet leather specimens.

Elasticity

Behaviour of the finish when the leather is stretched and extended.

a. Quick reference mandrel or key test.

b. Test with Lastometer (IUP 9) or Tensometer (IUP 13).
Assess the changes or the breaking of the finish coat before the grain cracks.

Fastness to hot ironing

a. The leather specimen is placed over a slightly rounded edge and plated once back and forth with a hot iron maintained at a constant temperature by thermostat. After each ironing, the test temperature is increased by 25 degrees Celsius. The change in shade, smearing and damage to the finish coat are assessed.

b. Test with VESLIC automatic hot ironing tester (VESLIC rub fastness tester with heatable finger).
The finger has a size of 10 mm x 10 mm and is moved back and forth five times after which the temperature is increased by 20 °C. This is repeated until the finish coat shows damage, smearing or change in shade.

Resistance to hot air

The leather specimen is submitted to the action of a hot air stream at 150 °C for one minute. The change in shade and other changes in the finish coat are assessed.

Fastness to hot steaming

The leather specimen is placed in a test chamber at 65 °C and 100% relative humidity. The migration of dye, bleeding and swelling are assessed.

Light fastness

The light fastness is tested with the xeno tester (cf. page 274).

Resistance to solvents

Acetone is normally used for the test.

a. Test with SATRA rub fastness tester
One ml solvent is dropped on the unfinished side of the leather within 30 seconds. The test specimen is left lying with the finished side up for 2 minutes at room temperature, and it is then rubbed five revolutions on the tester under a load of 2.5 kg.

b. Test with VESLIC rub fastness tester
From the rub fastness tester, the base plate in the center of the carriage is removed and replaced by a felt over which the leather specimen is clamped with a distension of 5%. One ml solvent is dropped at the side on the felt, and after one minute, the leather is distended once again by 5% and it is then rubbed five times with a dry felt on the finished side under a load of 1 kg.

The finish coat is examined for swelling, softening or smearing.

Resistance to detergents and cleansing agents

Similar to the wet rub fastness test, the finished leather surface is tested with various test solutions.

Resistance to shoe polishes

The leather specimen is tested by rubbing with three basic types of shoe polishes.

Polishability

A drop of water (about 0.15 ml) is applied to the finished leather surface and allowed to evaporate overnight at room temperature. The leather specimen is rubbed with a dry cloth, if necessary after treatment with shoe polish, to determine whether any stains formed can be removed by polishing.

Resistance to abrasion

Measurement of the resistance of the leather surface to abrasion.

For this purpose, the VESLIC rub fastness tester is used on which the felt for the rub-fastness test is replaced by a rubber-based abradant surface 15 mm long and 3 mm wide that is rubbed along separate paths against the leather for a fixed number of times under a specified load.

Under a load of 2 kg: 10 to 50 rubbing strokes
Under a load of 5 kg: 5 rubbing strokes

The leather can be tested wet or dry.

The test specimen is examined for changes in the leather surface and for change in shade with the aid of the Grey Scale.

Resistance to ageing

The leather samples are conditioned in the drying oven for

a. 7 days at 60 °C or

b. 3 days at 80 °C

before they are examined for embrittlement or yellowing and for changes in elasticity and flexing endurance.

Fogging test (DIN 75201)

Fogging refers to the condensation of evaporated, volatile components of the interior automobile trim materials on the glass plates, especially on the wind shield.

The test consisting of two different methods is carried out with the fogging tester of Haake-Meßtechnik, Karlsruhe, Germany.

a. Reflectometric test
A car upholstery leather specimen is placed on the bottom of a glass beaker which is immersed to a certain depth into a heated bath(100 °C) regulated by thermostat. On top of the glass beaker, which is closed by means of a cleaned glass plate with seal, cooling plates maintaining a temperature of 21 °C are placed. The cooling causes the substances evaporating from the leather to condense on the glass plate.
The quantity of fogging condensation on the glass plate is recorded by measuring the 60° angle of reflection of the same glass plate (blind value) without condensation.

Fogging value F_R = quotient in % of the 60° reflectometer value of a glass plate with fogging condensation and the same glass plate without condensation.

b. Gravimetric test
Instead of the glass plate used in the reflectometer test, a light aluminium sheet is used here and the specimens are treated for 16 hours instead of 3 hours at 100 °C.
The condensate is weighed and reported in mg.

Both test methods prescribe that the specimens be dried for 7 days in a dissiccator using phosphorous pentoxide.

Important dimensions for analytic

1 percent (one part in a hundred)	0.01 gram per gram (=one hundredth of a gram/g)	0,01 g/g (10^{-2})
1 permill (one part in a thousand)	1 milligram per gram (= one thousandth of a gram/g)	0,001 g/g (10-3)
1 ppm (one part per million)	1 microgram per gram (= one millionth of a gram/g)	0,000001 g/g (10-6)
1 ppb (one part per billion)	1 nanogram per gram (= one billionth of a gram/g)	0,000000001 g/g (10-9)
1 ppt (one part per trillion)	1 picogram per gram (= one trillionth of a gram/g)	0,000000000001 g/g (10-12)
1 ppq (one part per quadrillion)	1 femtogram per gram (= one quadrillionth of a gram/g)	0,000000000 000001 g/g (10-15)

Suppliers of standard test methods

1. DIN standards	Beuth Verlag GmbH Burggrafenstraße 6 10787 Berlin or Friesenplatz 16 50672 Köln 1
2. IUC, IUP, IUF methods	German publications: Eduard Roether Verlag Berliner Allee 56 64295 Darmstadt English publications: Society of Leather Trades' Chemists 52, Crouch Hall Lane Redbourn, Herts., UK
3. VESLIC methods	Eidgenössische Materialprüfungs- und Versuchsanstalt für Industrie, Bauwesen und Gewerbe Unterstraße 11 CH-9001 St. Gallen
4. BS standards (British)	British Standard Institution Society of Leather Trades' Chemists 52, Crouch Hall Lane Redbourn, Herts., UK
5. NF standards (French)	AFNOR Tour Europe, CEDEX 7 F-92080 Paris la Défense
6. ISO standards	International Organization for Standardization Case Postale 56 CH-1211 Geneva 20
7. ASTM methods (U.S.)	American Society for Testing and Materials, 1916, Race St., Philadelphia, Pa 19103